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Featuring

Some Problems of
Highway Operation

New England Power
Interests Uniting



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SOME PROBLEMS OF HIGHWAY OPERATION

BY G. H. DELANO*

(Presented September 30, 1925)

HIGHWAY operation as originally conceived was an effort to protect the highway and the investment that the highway represented. Because of the rapid changes in the volume and character of the traffic this conception has been enlarged to include the protection of the traffic and the restriction of the use of the highway.

Protection to highways is required against vehicles which with their loads are heavier and bigger than the roads already built can carry without injury, or a new road can withstand if it is to be built with some regard to the cost. Legislation is the only remedy for such abuse, and such legislation has been obtained. Briefly, the provisions of the various acts in Massachusetts, in so far as they touch upon highway protection, are as follows:

Chapters 85 and 90 of the General Laws as amended by Chapter 180 of the Acts of 1925. — The weight of vehicle and load is limited to 14 tons and 800 pounds per inch width of tire.

Chapter 90 of the General Laws as amended by Chapter 457 of the Acts of 1924. — In Barnstable, Nantucket and Dukes counties the loads are limited to 10 tons and 500 pounds per inch width of tire.

This same limit may be applied anywhere at certain seasons of the year.

The length shall not exceed 28 feet and the width 8 feet.

Vehicles carrying personal property are required to have the weight of vehicle and the registered capacity marked on the side, and may carry no load in excess of registered capacity. If more than two tons' registered capacity, may not exceed a speed of 12 miles an hour, and if under two tons may not exceed 20 miles an hour.

* Maintenance Engineer, Massachusetts Department of Public Works, Division of Highways.

Chapter 159 of the General Laws as amended by Chapter 280 of the Acts of 1925. — Passenger busses doing business entirely within the State shall be licensed and in the case of State highways, their routes defined.

Chapter 90 of the General Laws as amended by Chapter 457 of the Acts of 1924. — Commercial trucks also may have their routes defined.

Chapter 85 of the General Laws as amended by Chapter 313 of the Acts of 1923. — The State, city, town or county may, where necessary, with respect to bridges for which they are responsible, post such bridges for loads of six tons or more. Furthermore, plans of all town, city or county bridges of a span of 10 feet or more that are to be constructed or reconstructed must first be approved by the Department of Public Works.

Chapters 81 and 84 of the General Laws as amended by Chapter 482 of the Acts of 1923. — The towns shall keep the roads within their respective limits reasonably clear of snow and ice, the Division of Highways co-operating on such routes as they may select.

Chapter 81 of the General Laws as amended by Chapter 428 of the Acts of 1924. — The Division of Highways is directed to erect at or near such crossings, underpasses and bridges on State highways as in its opinion are dangerous, suitable signs and lights to warn persons using the same at night of the danger.

Penalties are attached for violations, but the responsibility for the enforcement is, through provisions of these same laws, definitely placed with the towns. Infractions, while not general, are frequent enough to severely test the strength of all but the best of our roads, and the damage that may be caused is not always evident until it is too late to take any action toward apprehending the offender and thus prevent continuation of the offence. During the spring, however, when the older types of road are soft, and loading above the maximum limit as prescribed by law is apt to be apparent while the vehicle is passing, or attempting to pass, over them also at this time, more than usual attention is paid to the weights of vehicle and load.

There is no question but that this seasonal restriction, as it might be called, has done more to protect our highways than any other one provision. I have in mind one road about 20 miles in length, surfaced with bituminous concrete, bituminous macadam tar, and waterbound macadam, in sufficiently good condition to have gone for years without reconstruction, that, when suddenly used by heavy trucks as a detour when the usual routes became impassable, went to pieces so badly that many trucks became mired in the waterbound macadam portion. The other surfaces broke through in places and the whole became so rough and out of shape that practically all of it is now scheduled for reconstruction. This means the expenditure of a large sum of money long before it should have been necessary. All of this was before heavy loads could be barred from this class of roads.

In addition to the direct protection afforded the roads, definite

limitation of the weights, etc., also offers some assistance in determining the proper width and strength of the proposed surfaces. Inasmuch, however, as the strength of the road must be great enough to withstand any load that may come upon it rather than any load that should come upon it, a rather large factor of safety must be used. The first-class bituminous macadam and concrete roads being built today seem to have satisfactorily solved that problem. In designing the width, however, there being no legal limits as to volume, it is, where there is any question, necessary to resort to a traffic census to determine the number and character of vehicles that use the road in a given time, and increase that count in accordance with the increase shown since the last census taken on that road. Due allowance must be made for the trucks and motor busses that are increasing in numbers so rapidly, particularly on the main routes. It is right here that restrictions of through trucks and busses to certain roads are certain to be very useful.

WIDTHS AND CURVES

Until recently the road surfaces were built 18 feet wide on the tangents and widened on the curves in accordance with standards that in some instances required a width of 24 feet. These standards were worked out on a basis of degree of curvature and speed, and provided for proper banking. Later some increase was made in the width of surface constructed on the main routes, but even then there was provision for but two lines of travel. This, with the increase in the number of passenger vehicles, large, slow-moving trucks, and of motor busses, means more passing of vehicles moving in the same direction and not much room in which to do it. The Department is constructing one road, and contemplating the construction of another, each being a good example of how the width and design has been worked out to meet existing conditions. One is between Canton and Stoughton on a route that is heavily traveled, and receives a large amount of heavy trucking. The surface is being constructed of two strips of concrete, each 10 feet in width, separated by an 8-foot strip of bituminous macadam. On such a road the benefit to be derived from this design is very apparent. The two lines of travel passing in the opposite direction will each have a distinct lane of concrete to travel on, and will, without question, adhere to it, so that when a vehicle wishes to pass in the same direction it will be possible to do so, both easily and safely. The second road leads to the South Shore, on a route that receives a large summer traffic. Many of the vehicles are motor busses, but few are heavy trucks. This type of

traffic does not require so much turning out to pass vehicles going in the same direction, but its volume does require a rapid outlet. Here the surface, if built as contemplated, is to be 40 feet in width, thus providing for two lines of traffic in each direction.

Some of our main routes, however, are surfaced but 18 feet wide, and do not meet the standards of present design as regards width, curves, etc. The surfaces in general are in excellent condition and would require widening only to make them adequate to efficiently carry the traffic. Some have already been widened and more will be during the coming season. Curves also are being straightened and widened as rapidly as the funds available for the purpose will permit. It becomes evident that more may be required for this purpose than might at first be imagined, when it is realized that in two of the counties on State highways alone there are about 300 curves of 300 feet or less radius, and about 800 of 300 to 500 feet radius. While it is true that all do not need improvement, it is safe to assume that of the 1,100 curves in question, 500 of them will. At an estimated average cost of \$1,500 for each curve, it is apparent that the amount needed for the whole State is more than can be made available.

The great problem, therefore, in providing road surfaces of proper width, grade and alignment is not so much one of design as of funds.

SNOW REMOVAL

Another item of highway operation that is now receiving more and more attention is snow removal. It has come to be generally recognized that the investment in roads and equipment and the dependence of the communities upon the commodities that are brought in over the road demand that the road shall be reasonably open at all times. Although the towns are required to keep *all* roads open, including State highways, the Division is authorized to co-operate with the towns on such routes as are approved by the Division as being of particular commercial importance.

The State is empowered to co-operate either financially or by furnishing equipment, and it was the latter form that was adopted, about one hundred 3-ton trucks and twelve 5 and 10 ton tractors being available for the purpose. Over 200 blade plows were purchased, with which to equip the trucks which the Department owned and such trucks as the towns or other agencies could furnish. All of the main routes of the State were approved for clearance, and equipment distributed to such towns on these routes as had no snow removal equipment. The

tractors were located at various central points to be used in emergencies to help out trucks that were unable to clear the roads. These tractors are equipped with V-shaped plows and do good work, but, in general, not being as fast as the trucks, are not as satisfactory for the usual storms. The V-shaped plow occupies practically the entire width of the road, and this forms an obstruction during any time when the roads are being used by motor vehicles. In Berkshire County, where the snowfall is undoubtedly heavier than in most parts of the State, 10-ton tractors are used exclusively to clear the main routes. The county has taken a very active interest in the work and has furnished four 10-ton tractors to be operated by the towns. During the past year the State furnished two 10-ton tractors to assist in this work, and this year proposes to add another.

The equipment thus distributed is to be operated by the town and the town is to bear the cost of all repairs. Inspectors are employed by this Department to supervise the work being done by the towns. Their function is to be sure that the equipment starts promptly, as in some cases it is only in this way that the lighter type of equipment can hope to cope with some of the storms. It is also desirable that the snow be entirely removed from the surface, and it is part of the work of the inspector to see that this is done. These men are also required to make prompt report to headquarters of any broken equipment or of any equipment that is in need of assistance. In such cases another truck and plow is sent out to replace the broken equipment, or a tractor is summoned from the nearest central point to assist the truck that is stalled.

More attention is now being paid to the formation of drifts. A study of the cause of drift formation seems to indicate that any obstruction on the side of the road that may cause the wind to lose velocity is very apt to cause a drift. Such obstructions generally are in the nature of hedges, walls, trees, banks and even weeds. Anything that can be done to lessen the number and amount of drifts will go a great way towards solving the problem of snow removal, as it is generally found that when there is any trouble in opening a road it is because the snow removal equipment was unable to get through a drift. Furthermore, it is frequently found that a road that has once been cleared through a drift, particularly when a vertical cut is left, quickly fills in again. Where the snowfall has any degree of permanency, it has been found that if furrows are formed in the snow on the proper side of the road and about 150 feet away a snow fence is formed that will prevent drifting. It is, of course, in such cases necessary to renew the furrows from time to

time. Where this cannot be done, the prevailing drifts should be located and snow fences erected wherever necessary. This State has not as yet adopted the policy of erecting snow fences. Many of the towns are, however, doing so, the practice is spreading, and there is no question but that with the development of the snow removal program the erection of snow fences will be considered an essential part of the work.

During the winters of 1923 and 1924 about 1,000 miles of main routes were cleared in this State, through the co-operation of the towns and the State. During the coming year it is proposed to clear about 1,500 miles in this way. None of the routes in Berkshire County are included in these mileages.

An effort is to be made, also, to remove completely, using road graders for the purpose, such snow and ice as may remain on the State highway after the snow removal equipment has completed its work. If this can be satisfactorily worked out, it will mean that the surface will dry out much more quickly, and, in the case of a thaw followed by a freeze, bad conditions will frequently be avoided.

Many sharp curves, both horizontal and vertical, and the narrow surfaces, bridges, etc., on the old roads require most of the attention devoted to the protection of those who use the roads. Intersections are always bad, their degree depending upon the volume of traffic and the speed of the vehicles. On new roads the alignment, width and surface more generally permit of higher speeds, which greatly intensifies the problem that arises in connection with the traffic control at intersections.

HIGHWAY SIGNS

It has long been apparent that the motorist should be given advance information of the approach of dangerous places on the road where caution is required, and signs of varying size, shape and wording were erected by many different agencies. The great number of such signs, their vagueness and lack of uniformity, caused the motorist to disregard the warning that they were intended to convey. Furthermore, there is also arising, as the routes are developed and extended, a need for informational and directional signs.

The measures to be employed to control the traffic on curves, narrow pavement surfaces, bridges and intersections fall into two classes, — those that *inform* or *warn* the motorist that he is approaching a point of danger where caution is necessary, and those that not only advise him of this fact but *control* his lateral movement upon the surface and at any point on a road where an element of danger exists.

Efforts were made by the individual states to guide and warn the traffic by painting symbols on the road surfaces, a T to the right or left to indicate an entering road, a cross to indicate a crossroad, a center band on curves to keep the travel on the proper side of the road. These symbols were painted in white, were a move in the right direction, and have not as yet been improved upon. The T's and crosses convey definite information, and the center band is extremely helpful, particularly where the surface is narrow. No particular co-ordination, however, was received with respect to any other type of warning sign. The same lack of uniformity existed with regard to direction signs. An effort was made to indicate certain main routes by the use of colored bands. The amount of information, however, that could be conveyed in this way was very slight, principally the compass direction of the route. This was followed by the use of route numbers, a black digit painted on a yellow background designating certain routes that were laid out and designated as certain interstate routes. The numbers of all of these routes were under 100. At the same time this Department laid out certain routes that were entirely within the State; the numbers of all of these were above 100, and the word "Mass." was used in connection with them. Most of the states adopted this system, but with variations, so that the same route would have different numbers in different states, and the color of the route numbers would also be different.

Some of the western states went a step farther and formed associations and established standards. One example of this was the work done by the Mississippi Valley Association, which established standards covering most phases of an informational, directional and warning nature. The American Association of State Highway Officials also recognized the problem and made recommendations that would cover all of the standards of this description that would be required for highway use.

The American Engineering Standards Committee also prepared a revised draft of code, colors and form for traffic signals for highways and vehicles.

STANDARDS ADOPTED BY JOINT BOARD OF INTERSTATE HIGHWAYS

Eventually all of these different movements were brought to a head by the Secretary of Agriculture, who, acting, I believe, upon a recommendation made to him by the American Association of State Highway Officials, appointed a Joint Board of Interstate Highways to

consider all of the problems in connection with the formulation and adoption of a uniform system of road signs, and to further lay out and adopt a system of interstate routes that would cover the entire country.

A preliminary meeting was held in April (1925), followed by regional meetings in various parts of the country to consider the roads that should be recommended as interstate highways. Subcommittees were appointed to prepare recommendations to cover the shapes, colors and wording of whatever signs might be decided upon to direct and warn the motorist. The final meeting was held in August, and a system of interstate roads and a series of standard danger, caution, directional and informational signs were adopted.

In their deliberation, the Joint Board was guided by the consideration that information should be conveyed to the motorist through the *shape* and *color* of the *non-luminous* signs, and the *color* of the *luminous* signs. Accordingly, for the non-luminous signs the following shapes, standards and colors were adopted:

A circular sign 24 inches in diameter with a yellow background and black cross, with the letters R.R. also in black in the upper quadrant, for use at railroad grade crossings, in such states where the legislation had not already prescribed a different sign. In this State the law specifies that a circular sign 24 inches in diameter with a white background and a black cross and letters shall be used.

The standard "Stop" or "Danger" sign is a regular octagon with the word "Stop" in black letters on a yellow background. Yellow was adopted as the color of these signs because it was thought that a permanent red could not be produced. Subsequent action, however, seems to indicate that the red paint used by the Navy Department on buoys, etc., will be sufficiently permanent, and it may be that the Joint Board will rescind its action in this respect. This sign is to be used only where a real danger exists and the motorist should come to a stop.

The sign to be used where caution is required, without coming to a stop, is diamond shaped, with a yellow background and in black the word or words to designate the nature of the conditions ahead, such as curves, hills, loose gravel, etc. In cases where a lesser degree of caution is required, such as on the approach to a schoolhouse, a square sign is to be used. The background is to be yellow, and in black will be superimposed the word "School" or other notice as may be required. All directional and informational signs are to be rectangular in shape, with a white background and black letters.

We have, therefore, submitted for our use, an octagonal sign that indicates a positive danger, a diamond-shaped yellow and black sign

that indicates the need for caution, a yellow and black square sign to indicate the need for a lesser degree of caution, and a black and white directional sign. All are to be 24 by 24 inches outside dimensions, except the directional, which are to be as required by the number of towns indicated.

The standards submitted covering the luminous signs are red for danger or stop, yellow for caution, and green for go. In this State but few of the red signals will be used by this Department; most of them will be yellow.

These standards now make available suitable devices to cover almost any condition that may arise.

The intelligent application of the standards requires, however, a careful diagnosis of the problem, which will, if correct, indicate the device or devices to be selected and the proper location of same. Some latitude may be permitted in the choice of signals, but little in the location. The signal selected should indicate to the motorist the degree of danger, through outline and color; the nature, by a descriptive word; the direction, that the road curves by an arrow; and every signal should indicate to the motorist the necessity for alertness and for having his machine under control. After the motorist has seen the signal it may take an appreciable interval of time to grasp its significance, bring his machine under control, and be prepared for the conditions of which he has been warned. During this interval his machine will have traveled a distance dependent upon the speed at which he had been moving. The warning should therefore be conveyed sufficiently far in advance of arrival at the point of danger or caution to permit the motorist to act intelligently and in time. This can be done by locating the signal some few hundred feet in advance of the point that is posted. Inasmuch as beacons and the reflection of headlights are visible at night for several hundred feet or more, it is possible in some cases to locate beacons and self-reflectors at the actual point of danger, and still convey the advance warning.

In addition to warning and information furnished to the motorist, it is in some cases necessary to restrain him laterally to that portion of the surface intended for his use. Such conditions arise on long radius curves where the tendency is to maintain speed by taking the inside of the surface; a white line does not always help on such curves. Short radius curves, however, impose the necessity for speed reduction, so that the motorist is thereby able to stay on the right side of the surface. On such curves a white line is a help and is more generally observed. On the long curves, however, where the white line may not be observed,

some device of such a nature as to compel the motorist to stay to the right is sought, and generally found in the beacon. Lateral restraint is also required at times at intersections to compel the motorist to pass the intersection of the center lines of the traveled ways before making a left turn. Here, again, the beacon, on a heavy concrete base, has been found to be about the only device that will produce the desired effect.

It is frequently found, however, that the surfaces on curves and at intersections are not wide enough to permit the erection of a beacon and to permit at the same time the safe passage of the vehicles. In other cases it becomes evident, when conditions have been studied, that even though the surface is wide enough the location of a beacon in the center of an intersection is inadvisable, as it may cause some other machine in turning to make too wide a turn and therefore be out of position. Where the surface of a curve is not wide enough for the beacon, the surface should either be made wider, if conditions are very bad, or the beacon omitted entirely. At intersections where the surface is not wide enough to permit, or local conditions prohibit the erection of a beacon at the center, an effort should be made to locate the signal in the throat of one or more of the entering ways. In general, at the intersection of the entering road it will be found that one signal at the throat of the side road will suffice, and at intersections two signals will do. No beacon or other devices that constitute an obstruction should be placed on the surface of the highway, particularly at a point where it is considered that an element of danger may be present. Every effort should, therefore, be made to solve the problem without the use of a beacon on the surface, or, if such is considered necessary and it seems that one can be erected without increasing the element of danger, it should be placed in the throat or throats of the entering roads.

The various types of beacon available for highway purposes fall into two general classes, — the self-reflector type and the beacon type, which uses either a flash or a steady light operated either by acetylene gas or by electricity. There are, of course, other types of electric signals more generally used for traffic control purposes in cities, and which will not be included in this discussion.

The self-reflector type of beacon is composed of many mirrors set in different planes, so focused as to reflect the headlights of an oncoming automobile, either straight back or from the side. Such a signal located at the side of the road is extremely efficient under certain conditions, in giving advance warning of approaching intersections, curves, sharp hills, etc., and can also be used directly at the curve itself, so located as to be in the path of the headlights.

It is not considered, however, that the reflector type of beacon is as efficient in warning and guiding the motorist as the flashing beacon type. The flash emanating from this type of beacon is generally about one-tenth of a second in duration. The interval between flashes is longer. Adjustments of both are possible, however, but the flash is kept to a minimum, not only because the light is so intense, but in an effort to conserve the supply of gas. The gas is furnished in a metal cylinder and is supposed to last approximately six months, a fresh supply being forwarded about a month before the expected expiration of the existing supply. The light is emitted through a lense that is focused about 300 feet down the path of the approaching machines.

The electric type can, of course, be used only where there is electric current available, and such is not always the case. However, they have a wide variety of uses, are easily and cheaply maintained, but, of course, do cost a little more to install.

A standard has never been established for the color of the lenses of these signals. In some cases it will be found that the color of the lense is red, and in some cases green, and in others yellow, all used to designate the same type of danger. Some difficulty was at first experienced in procuring a true yellow for the lense, as it was noticed that the yellow lense provided for use in the signals more frequently appeared to be red.

This Department has established no standards covering self-reflector and flashing beacons other than what has been included in the standards adopted by the Joint Board on Interstate Highways.

With respect to directional and informational signs, the adoption by the Joint Board of Interstate Highways of a system of routes to be known as Interstate Highways indicates a desire on the part of the motoring public that they be furnished with some means of knowing when they are on that route, where it goes, and to enable them to continue with it. Accordingly, for these particular routes a standard route marker has been adopted which is to be a typical United States shield, with a white background on which is to be in black the name of the state in which the shield is located, the initials U. S., and the route number. A smaller white shield has also been adopted, bearing the letters R or L, to be placed in advance of the curve, to indicate the direction that the motorist should look for his route. At the curve would be an arrow pointing in the proper direction. The Joint Board has also adopted standards for directional signs. Such a sign has already been prepared by this State. This sign is on sheet metal, mounted on a concrete post, has been made rustproof, and painted white, on which will be lettered in black the route number, an arrow pointing in the direction

to be followed, and four town names, with their distances. These signs are to be 42 inches in width and 37 inches in height. The following system is used in the town names:

The first name is to be the next town on the route, the second the next important center, the third the next junction with another route, and the fourth the last town in this State on that route.

In conclusion, I would state that highways may be properly designed and posted but no benefits will be derived as a result, and I am referring now entirely to the degree of safety involved, unless the motorist understands the devices that have been used and is willing to abide by the advice or warning given him.

In establishing standards of such devices and placing them at the various points where needed, it is always necessary, therefore, to have in mind the interpretation that the motorist may put upon them and the course that he may follow as a result. The only benefit to be derived from such devices is the benefit derived by the motorist himself. All such work should, therefore, be conceived and executed with the motorist in mind.

The utmost publicity should, therefore, be given to the type of signs to be used and their meaning, as it is only by educating the motoring public to understand and use these devices that the road problem is to be solved.

Discussion

LEWIS E. MOORE:* My remarks will be of a rambling nature with reference to the colors used for signs and to the general unwillingness of human nature to learn from experience.

I am glad to note that the Massachusetts Division of Highways has adopted yellow as a background for their signs, for the reason that yellow has been found by railroad signal engineers to be the most visible color under all conditions of light. The railroad men, though, have not been willing to follow this yellow indication to its natural conclusion, or to follow out the teachings of the war with respect to camouflage.

One of the first lessons in camouflage is that concealment is obtained by breaking up the continuity of a surface or by breaking up its outline. If you have ever had occasion to hunt for a black and white cat on a dark night, you will appreciate what I mean. The breaking up of its outline by the different colors affords an almost perfect camouflage.

What I am driving at is this. The gates at railroad crossings and fences at various other places are barred diagonally black and white.

* Consulting Engineer, Boston, Mass.

This has the effect of breaking up the outline of the gate and reducing its visibility. It is also an expensive process to paint the gates this way. A plain, flat yellow color on crossing gates, or other objects which it is desired to make visible, would be both safer and cheaper.

While I am on the subject of signs, here is something which I have never seen in the East, but which is quite common in Indiana and is a great help to strangers. As you drive along you see a sign about one hundred feet before you come to a crossroads saying, for instance: "Chicago, next right." That is a great help to one in a strange place. I don't know what it is unless it is a wise Providence that guides the stranger through Boston.

The question of traffic control was not touched upon by Mr. Delano. It is a very large subject and I will only attempt to present one or two points which I think will be of interest and use. It is interesting to compare the early days of railroad signals with these days of traffic signals. The railroad men at first objected to an automatic signal system, saying that it would stop the trains. Before long they found out that, properly installed, it increased the amount of traffic that could be handled. The highway signals should be so installed that they will increase the amount of traffic that can be handled, as well as adding to its safety.

You are all familiar with the method of traffic control used on Fifth Avenue, New York, where all the signals used on the Avenue are on for a certain length of time in a certain direction. The traffic direction then changes and all traffic on the whole length of the Avenue is stopped while traffic moves across it. This system is incorrect from at least two viewpoints. One, which is easily corrected, is that the yellow light, almost universally used for caution or slow-speed moves on the railroads, is used for high-speed moves on the Avenue. The green, or clear light, indicating a high-speed move, is used for cross-town traffic, which is generally slow, and the red light is used to stop all traffic, the latter being correct. What should be done is to show the green light to the man who is going to move, that is, a green light should be shown shining up and down the Avenue when it is desired to move traffic on the Avenue, and it should be shown shining up and down the cross streets when it is desired to move on the cross streets. It is only necessary to show a green light or a red light in a direction such that it will be seen by the traffic which it is desired to have move or stop. The yellow light on the roadways should be used only where caution is to be indicated. It may be used in the interval when traffic control signals are changing from green to red.

The latest development in traffic signals for long streets is as follows: The signals automatically change from red to green at definite time intervals. Successive signals on the same street do not all change at the same time, but change successively and progressively. With such a system it is possible to start in a car at one end of a long street and continue moving the whole length of it, always getting a green signal at intersections and never stopping. Each signal will change to red some time after the car has passed it, and when it changes to red, cross-town traffic moves across the street behind the car. Now this type of signal will allow a particular car to keep moving all the time it is on a given street, and yet it allows cross-town traffic to move across the street both before and behind it safely.

There is an improvement in traffic conditions in this case which I have never seen mentioned. In the case of signals such as are used on Fifth Avenue, where all the traffic along the Avenue is stopped at intervals, the natural tendency is to drive as fast as possible as soon as a car is allowed to start so as to get as far as possible before it is stopped the next time. But the progressive changing of signals operates as an automatic controller of speed. If a driver finds that if he starts at the beginning of a street and receives a green light at the next crossing, and continues to drive at, say, 25 miles an hour, he will receive a green light at each crossing ahead of him, he will drive at that speed. If he tries to drive faster, he will catch up with the changing of the lights and a red light will oblige him to stop. His natural tendency will be to drive at such a speed that he can keep moving, and so this type of automatic control should operate not only to handle traffic at crossings, but also to solve the overspeeding problem in long city streets.

PROF. CHARLES B. BREED:* Mr. Delano has done remarkably well to cover his subject so completely in his short paper.

A point which he did not overstress, and which seems to me of great importance in highway informative signs, is to make the sign read in as simple language as possible. You will notice in traveling through the country, in some cities in particular, a dissertation set forth on a sign on some corner, no part of which is readily readable because the lettering is too small. The driver's only hope is to stop his car and make it his business to stay a while and read the treatise. It is well to incline far to the other extreme in adopting wording for highway signs. They should contain the least number of words and still maintain clarity. It is a fact that "Go Slowly" is better English than "Go Slow," but the proper

* Professor of Railway and Highway Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

wording for such information is the word "Slow." It means but one thing to all minds.

I cannot see, for instance, why it is necessary to put the word "Mass." on top of the route signs in this State. Why continually tell a man as he passes through the State that he is still in Massachusetts? The same criticism applies to the "U. S." above the route number on the Federal routes. If the lettering were omitted from these signs and merely the number and color schemes used it seems to me that they would better serve their purposes. It may be advisable to place the letters "Mass." above the route numbers for the first half a dozen signs only when passing across the border into this State.

I advocate black block letters on a yellow background, with a characteristic shape. Uniformity of signs is very desirable, because the motorist passes from state to state and uniformity materially helps him.

While driving down from Maine a week ago I particularly noticed the clear route signs in that state. In many things the state of Maine is not ahead of Massachusetts, but in their route signs they certainly lead this State.

It is important to eliminate signs which tell of a dangerous condition which really does not exist. Signs reading "Danger" appear at curves which in reality are not at all dangerous. If the motorist becomes accustomed to find that the signs foretell danger where it does not exist he will become accustomed to disregard all such signs, which would be a truly dangerous state of affairs. Where one can operate safely around a curve at 35 miles an hour without any discomfort the necessity of a "Danger" sign does not exist.

I am inclined to adversely criticize the design of the direction arrow on many of the route signs; the arrow head is not big enough. Frequently on approaching a turn one has to strain the eyes to determine on which end of the line the arrowhead is; either the shank of the arrow should be a thinner line or else the arrow head should be larger.

The wording on any sign should tell the same story to all minds. It should mean only one thing and that the right thing. Instances of this are those that read "School," "Stop," "Slow." If there are more than two words on a sign many motorists cannot read them in the short interval of time available.

The word "Stop" should never be put on a sign unless it means *come to a dead stop*, unless it be a mandatory signal. It is seldom necessary to put "Stop" on any highway, because the operator can control the path of his car. It is obviously necessary in railroad signaling.

With reference to the color — a yellow background with black letter-

ing — that is the right combination. I never had the experience suggested by Major Moore of hunting for a black and white cat at night because I have the misfortune of having been brought up in the city. But I have often visited in the country and it has been impressed upon me by those who reside there that it is the height of impropriety for any one to go out at night and hunt for a black and white cat. [Laughter.]

Now with respect to uniformity in the weight of the loads and in the maximum sizes of vehicles in all states, it is a good thing but it is not wholly practicable. There is a large difference in this respect between the laws of Massachusetts and those of Vermont, for example. Vermont is a relatively poor state and cannot support a construction and maintenance program sufficient to maintain a complete highway system sufficiently strong to carry 14-ton loads, as Massachusetts can; her limit has to be very much lower than Massachusetts.

Keeping the roads open all winter is a practice that is increasing because the motor is being used more and more for winter travel, and the motor bus and the motor truck are in constant use and require passable roads all the year round. The growing tendency for private closed cars instead of the open touring car tends to encourage owners to use their car throughout the year instead of putting it up for the winter, as was formerly the practice. Roads available throughout the winter is a step in the right direction, but, as Mr. Delano suggested, it is necessary to move the snow promptly so that the road may dry out quickly. This means that the snow must be removed as soon as it comes. The crew must get out as soon as the snow begins to fall.

The Joint Board of Interstate Highways without doubt is doing a great deal to assist in bringing about uniformity of design of highway signs. I believe that we can go even further toward simplicity.

G. H. DELANO: * Professor Breed's points are all well taken. The "Stop" sign, as he says, should be sparingly used. In that respect, as far as this Department is concerned, there will be but few such signs. I can think of but one or two places where the octagonal sign might be used. One is where there is a road under construction and there is an absolute barrier to traffic. On sharp curves I think the tendency of the various agencies will be to use the "Stop" sign and a red light, or possibly a red flashing beacon where only precautionary signals are required.

Professor Breed's comment on the arrow is a very good one. In working out an arrow to be used on directional signs it is important that the head be clear and discernible just as far as the letters on the town name. The arrow on those signs is intended to convey advance informa-

* Maintenance Engineer, Massachusetts Department of Public Works, Division of Highways.

tion to the motorist at a time when he should get it. That same theory would also cover what Professor Breed said about having signs with small lettering and many words on them. The arrow with that information should be placed in advance of the turn in order that the motorist may be free to concentrate his attention on the operation of his machine. For that purpose we are putting the route number with the arrows some 300 feet in advance of the intersections or turns. Just beyond the turn will be another number, so that just before the man makes the turn he can look to right or left as the arrow has indicated, see the next number, and be able to confirm his judgment. Then on the next pole will be still another route number that will make him sure that he is on the right road.

With regard to the word "Mass." on the sign. Those signs were adopted at some conference of the highway officials. At first we did not incorporate the word "Mass." in them, more from oversight than intention, and we began to get inquiries and complaints until finally we put the State abbreviation on. I think the point is well taken and should be considered.

As regards the loads on the roads, the Professor said that this State was in better shape than Vermont. I hope we are, but at the same time we have not yet reached the point where all of our roads are so completely resurfaced and reconstructed that there isn't some link in them that will suffer severely from heavy traffic. We are endeavoring to correct this, but we have still many weak links in our highway system.

FRANK O. WHITNEY: * I think one of the most convenient signs used at crossroads and diverging roads is the name of the destination printed in large white letters on the surface of the roadway, with an arrow giving the direction. I have seen in Jamaica way, for instance, on the surface in the center of the roadway, in large letters, "Providence." That catches the eye at once. I have noticed similar signs in some places going toward Plymouth.

It seems to have become quite the thing to have white stripes along the center of the road on curves. In a few cases I have seen them extend quite the whole length of the road. I think that is a very desirable precaution. I have in mind a road between Stoneham and Reading where the white line extends all the way from one town to the other. It helps us keep on the right side of the road. We unconsciously get into the center of the road and sometimes too far over on the left-hand side. The construction of the road has something to do with this. On some roads the crown is so great that it is difficult to guide the car except in the

* Formerly Chief Engineer, Street Laying-Out Department, City of Boston.

center. With the white line we naturally keep where we belong. With present methods of construction the roads should be made with as little crown as possible, just enough to keep them dry.

I have had some experience, also, with regard to these signs with a lot of small lettering. I wish there was some law which would keep all signs off the main highways which relate to things other than the guidance of traffic. There are too many small advertising signs. I was going along a road one day and came to a sign 2 feet square with "Stop" on the top of it and some small lettering underneath. It was impossible to read the story so I did "Stop," and it said, "Green corn for sale 300 feet from here." Those signs are confusing, to say the least.

I think there is a great lack of street signs. I have occasion to go about Boston within a radius of 15 to 20 miles looking for streets in the different towns. I may be looking for some particular highway and a sign reads "John Henry Square," and that is all I can find. I don't care anything about John Henry or his Square. I am looking for a street and want to find the name. There has been much in the papers lately about the inadequacy of the Boston street signs. I believe they estimate that it would cost \$100,000 to properly designate the streets of Boston. I was in a town recently within 10 or 12 miles of Boston and couldn't find a street, and I said to one of the old inhabitants of the place, "Why don't you have some street signs down here?" He said, "You don't have any in Boston."

Have you ever noticed, as you go along the highway and want to find a certain side street, the street signs seem to be back towards you, and you have to drive by and stop and look round and see what that street is, and then if it is the street you want you have to go back and make a second start? I think that street signs, as far as possible, ought to be on top of posts with the name on both sides of the sign, so that it can be read from whatever direction it is approached.

GEORGE H. NYE: * When a man is driving his car, particularly in traffic in the city, he is busy and has about all he can do to drive properly. Although he is busy with the operation of the car he yet wants to know where he is going, and I believe every effort should be made to give him the clearest, simplest signs he can possibly have. For that reason I am thoroughly in sympathy with the adoption of the yellow background with the black lettering exclusively for the guidance of automobilists, by signs that show direction and warnings. Thus the man driving a car in traffic and looking for his way, when he sees black on yellow, knows it is something that is for his information. I think it would be

* City Engineer, New Bedford, Mass.

well to go a step farther and prevent the use of black on yellow for anything but traffic signs. We certainly can control the signs on the poles and trees along the streets. On a building, of course, anybody has a right to use the black on yellow for advertising, but in the streets these signs should be for the automobilist only.

With respect to those "Stop" signs which have been referred to, I had an experience with one which read "Fried clams." The State is just covered with such signs. A man sees a "Stop" sign and goes by because he thinks it an advertisement, and then he hits something.

Mr. Delano spoke about the beacon poles which are placed in the center of crossroads. I guess they are a good deal like boils — the best place for them is on somebody else's neck. Those things are a real menace, and the public is more or less responsible for them. Most of those I have seen have borne the scars of battle.

I would like very much to know how the overhead signal is working out. It seems to give the warning signal far enough in advance, but whether it can be used to indicate a turning point or not is doubtful. If practical it seems to me it could be placed in the center, even, of a narrow street to give warning of a dangerous crossing.

MR. DELANO: I have had a very limited experience with overhead signals. I recall that we did have one particular intersection called to our attention and that we tried the overhead signal there. It appeared to be a very good signal, had four lenses and a very powerful electric light. So we put it up, suspending it, of course, high enough to clear the trucks. But it was so high that it appeared small and didn't do much good. I am not sure yet that the overhead signal will be a success on intersections, but from that one experience I wouldn't be justified in thinking that it will not.

MR. NYE: We have two locations where we are thinking of using them, and in both cases they are intersections of rather broad streets, straight for some considerable distance and without trees. In one case such a signal could be seen for a mile.

MR. DELANO: In such a case that seems to be about the only thing to do now. You don't want obstructions. In the case I mentioned I could see nothing else to do except to put up warning signs, so we put up the yellow warning sign.

PROFESSOR BREED: I think the advance warning sign is desirable, because, as Mr. Nye says, the autoist is busy, his eyes are usually on the road in front of him. That is why the cross or T sign on the road surface is so helpful. Of course that type of sign is expensive to maintain and keep in brilliant condition all the time, especially in

heavy traffic; it fails entirely in winter when snow lies on the pavement.

The idea which Mr. Nye brought out, of the necessity for quick mental action, is worthy of consideration. Automobiles cover the ground pretty rapidly, and the driver's eyes are usually on the road. He glances quickly to the side to look for signals. These signs should therefore be located in the places which his eyes naturally seek, and not too high above the road surface.

I have seen them placed so high they cannot be read, on account of the sun shade on the front of the car which many drivers need for eye protection. The color of sign of course is a great aid. Road signs, however, should be placed just as low as possible because the eyes of the driver are following the ground.

If you place a sign up 14 or 15 feet above the road so as to clear high loads, that is too high for a man to readily read the lettering. I believe it is true that in general the overhead sign is less valuable than roadside signs which are placed sufficiently in advance of the danger point.

MR. NYE: It may be of interest to add that we have used the signs painted on the road very extensively. We print them in letters about 4 feet high, right across the road. At first we simply painted "Boston" with the arrow on the street surface, but we found that didn't give all we wanted, as the signs were covered with snow in winter. For winter traffic we have adopted a route sign, which is an arrow about $3\frac{1}{2}$ feet long, set so that you face it as you approach every turn that you should make, and on it simply "Boston" if you are going north, "Cape Cod" if you are going east, and "Fall River" if you are going west, and the State route number. The arrow is yellow and the letters black and we set it at about the same height as the regular State highway mark on the pole, that is, about 8 feet above the street.

RAYMOND W. COBURN: * Relative to the direction of the arrow which Professor Breed spoke of, showing the direction of travel, I have noticed them on some of the large detour signs which have been put up, where the background is 5 by 4 feet or 5 by 3 feet. On these signs they have "Construction Ahead" with a large arrow and the name of the next town on the route which is closed to travel. Here I have noticed in some cases the automobilists come to a full stop and inquire from the policeman as to what direction they should go. This means that the arrow is not prominent enough. I believe that the arrow should be the most prominent thing on the sign, so that the first thing that the automobilist sees is the direction that he is to turn. Secondary to the arrow is the fact

* Construction Engineer, Massachusetts Department of Public Works, Division of Highways.

that there is construction ahead, and the town or city to which the detour leads.

On the highway between Canton and Stoughton, the dual type of construction is especially adapted, on account of the fact that there is a stretch of two miles of road, more or less, with no intersecting streets and no houses. For that reason there is not much chance of any business parking on the side of the road. If this dual type of road were used where there were many houses, people would park on the side of the road, leaving their machines on the concrete and forcing the travel to use the center of the road. I believe that if a dual type is to be laid through a thickly settled village, there should be a shoulder outside of the cement concrete for parking purposes. The concrete, being the most expensive portion of the road, should get the travel for which it is designed.

Relative to the "Stop" signs, which two or three of the preceding speakers have said are being posted on the main road and used for purposes not intended, I would say that a few years ago while driving from Worcester to Boston, a man came out and waved a red flag in front of me, for which I slowed down, planning to come to a stop. A few hundred feet farther, another man came out with a basket of peaches. Obviously this is an abuse of the red flag or "Stop" sign.

STURGIS H. THORNDIKE: * That modified shape of arrow (on the diagram exhibited) seems to obviate the criticism of the customary horizontal arrow, and the difficulty of seeing which end is the arrowhead. You cannot very well help seeing that that sign points to the left.

What is the use of the word "Turn"? Does not such an arrow by itself tell the story, and can it not be made blacker and the sign simplified by the omission of the word "Turn"?

MR. DELANO: Those signs (exhibited at the meeting) are the standards sent us by the Interstate Board, and I have submitted them simply as samples of what we are putting up on the highways. The arrow in that sign is to give the direction of the turn. The driver sees it 700 or 500 feet in advance and knows that there is a turn ahead of him. There is another similar sign that says "Curve." That particular sign is meant to indicate a right-angle turn.

In deciding upon the proposed location for the direction sign there has been some question as to the interpretation the motorist would put upon the arrow; also whether the direction signs should be placed before or beyond any entering road that we do not wish to be used. Ordinarily

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such signs are at the intersections or turns. But in this particular case the point was raised as to whether the sign should be before the turn, beyond the turn or at the turn. We take the position that if the sign is placed beyond the turn there will be no question.

The two most important things on direction signs are the route number and the arrow. You should give these first and make them most conspicuous. After that the town names should follow in less conspicuous letters.

I have had a man raise the question as to whether an arrow indicating a left or right turn should not point up or down rather than to the left or right. I can't quite see it, but it was put up to me by a man who had given the question a good deal of study. I have seen one such sign, — an arrow pointing up when the indication to the motorist was intended to be to turn to the right.

OF GENERAL INTEREST

NEW ENGLAND POWER INTERESTS UNITING

Interconnection of Electric Utilities is Establishing Real
"Superpower" Development on a Regional Scale —
Centralized Financing and Management making Great
Strides

By Howard S. Knowlton, New England Editor, Electrical World

For several months the technical and newspaper press has been hot on the scent of electric power developments in New England, and with good reason. A remarkable process of centralization is under way in the financing, management and operation of the electric light and power companies of the Northeast. The prosperity of these companies has attracted the attention of investors and bankers from many points outside New England, and within our borders leading electric utility men have come together and joined hands for important activities in the upbuilding of this field. What is the meaning of it?

It seems clear that the day of the small, singly operated and isolated company is gradually passing, wherever that company is in close electrical reach of others of its kind. Many popular misconceptions exist in regard to so-called "superpower," and attempts are constantly being made to create political capital out of these developments. At bottom the definition of superpower boils down to the interconnection of generating plants, transmission and distributing systems to save waste of capital and waste in operating costs. Interchange of power between companies enables local loads to be carried at reduced overall

cost by taking advantage of the diversity of flow between streams on different watersheds, the non-synchronism of system peaks, and the availability of spare capacity in both steam and hydroelectric plants. The problems of such developments are not political; they are economic, and their solution by engineers — it is the engineers whose judgment guides to the right decisions in this field — is a technical matter which cannot properly be determined by politics.

As an example of the good interconnection can accomplish, we may recall that Columbus Day was a holiday in Massachusetts but not in Connecticut. One of the latest "tie lines" to be completed in New England connects the systems of the Turners Falls Power and Electric Company, the United Electric Light Company of Springfield, and the Hartford Electric Light Company. On this day waterpower from Turners Falls, which was not demanded in Massachusetts, was "shot" into Connecticut, and the entire load of the Hartford district was carried in this way, the steam plants at Hartford being completely shut down. Thus both water and fuel were saved, and it is a demonstrated fact that this tie line is saving thousands of dollars a month to the participating companies.

It has also cut down the amount of reserve generating equipment needed to safely handle the loads on these systems, thus conserving capital as well as fuel, water and labor. In emergencies the plants so tied together are freely pooled regardless of temporary losses in economy to make good the temporary failure of local power supplies, and this pooling is benefiting people in central New England far removed indeed from the individual stations involved in this network. This is not the work of a so-called "Power Trust!"

Ever since the World War began, this process of interconnection has been going on in New England, and it may truly be said that we now are enjoying the benefits of "Superpower by Piecemeal" — not a bad way, after all, in which to develop a great regional network from small beginnings. What is more generally known as superpower development includes the tying in of large and highly efficient plants built and to be built on tidewater with interior stations and hydroelectric plants in the more important valleys. This involves the erection and operation of high-voltage trunk lines on a scale not at present realized by the average engineer, and the pioneer work of W. S. Murray in this field is of very great importance.

It may be conceded that if a superpower system were to be built up on a comprehensive plan of action covering the manufacturing East, many features which have been incorporated into the more gradual developments which have been made would be modified; but in general the engineers who have put through these northeastern interconnections have done so with vision and ability. The use of voltages far in excess of those at present considered standard is apparently on its way, and the progress of the electrical art is so rapid that some capital is bound to be expended on developments representing the best opinions of

the time and place. On the whole, it is a fair statement that an excellent engineering job is being done in New England interconnection, and that few errors that cannot be repaired are being committed in this step-by-step progress.

Interconnection may or may not be associated with centralized ownership and management. The changes in control of properties which have come about in the past year or so can be mentioned only briefly here; but the acquisition by holding companies of not a few smaller properties has aroused intense interest. In northern New England the Insull interests have acquired control of the Central Maine Power Company, the Manchester Traction, Light and Power Company, Vermont Hydroelectric Corporation (of Rutland), and earlier, the Twin State Gas and Electric Company properties, not to say smaller units of importance in regional development and co-ordination of systems. It is reasonable to expect that interconnection will be extended in these states as time passes, in order that the existing plants may be operated together more advantageously (the Twin State company has already done some fine work along this line in upper New Hampshire and northeastern Vermont, and so has the Central Maine). The Portsmouth and Cape & Vineyard properties have been acquired, with other smaller units, by the White interests, who are also working into Connecticut; the Portland system, under the Emmanuel control, is interconnected with the Central Maine, and in Massachusetts and Rhode Island the great New England Power Company system has for some time been interconnected with the Boston, Providence, Worcester and many other company plants. A pioneer interconnection of great value has been operated for many years between the Tenney properties immediately north of Boston. The Montaup system, between Fall River, Brockton and Pawtucket, is now

at work, and in general most of the leading central stations and not a few of the industrial power plants of central and southern New England are tied together on advantageous terms. Better service at lower ultimate costs is sure to result from this movement.

The Insull interests have formed the New England Public Service Company to develop and finance their properties in this territory, and very recently the Stone & Webster interests, the Edison Electric Illuminating Company of Boston, the Hartford, Springfield, Turners Falls, Connecticut Power and Blackstone Valley companies, with the Power Corporation of New York, interests have agreed to participate in the financing of the New England Power Company system for mutual advantage and comprehensive expansion of facilities. There are still many independently operated companies in this territory, but gradually the electrical resources of New England are being co-ordinated (the Connecticut Light and Power Company, Waterbury, is adding important local companies to its system) into major groups, and there are stirrings of hope that the prohibition upon even surplus hydroelectric power exportation from Maine may relax into a future *modus operandi*.

These developments mean a carefully planned attempt to serve the public at lower ultimate cost, realizing great economies en route, cutting out wastes in administration, rendering more reliable service and establishing a simpler territorial set-up in executive direction. Some question has been raised as to the justification of the prices paid in certain cases for control of these smaller properties, but under commission regulation we may rest assured that the public will be amply safeguarded as to rates and service. The same sound scrutiny of securities that guides wise investors in other fields should be given here, and

snap judgments avoided. The wonderful possibilities of growth in the electric light and power industry must be given due weight at all times, combined with intelligent analysis of actual attainments and discriminating study of the potentialities of specific properties and groups of properties involved in these great and striking changes of control.

Prizes Offered for Highway Essays

Realizing the scarcity of highway engineers, and the need for additional engineers to carry on the great amount of work being done by the highway industry, the American Road Builders' Association is attempting to interest the college student and attract his attention to the importance of highway transportation to the progress of the country, by offering \$550 in prizes for the best essays on the subject "A New Nation by Improved Highways." The contest is open to all college students.

The essays will be judged, prize winners announced, and prizes awarded by the American Road Builders' Association at their convention in Chicago during "Good Roads Week," from January 11 to 15, 1926.

Essays must not exceed 600 words, and should be addressed to Essay Contest Committee, American Road Builders' Association, Congress Hotel, Chicago, Ill. They should be received before January 1, 1926. Further details of the contest are set forth on the poster being sent to all universities and colleges in the United States.

Widening and Banking of Highway Curves

The accompanying table and diagram illustrates a new standard for widening and superelevation on curves recently

adopted by the Massachusetts Department of Public Works.

This standard is figured for a 20-foot width of roadway, but is applicable with certain modifications to an 18-foot roadway. The flattest curve banked has a radius of 1,600 feet, and the sharpest curve considered has a 300-foot radius. Any curve with radius less than 300 feet is to be considered a special case.

Widening of Curves

The maximum widening is 5 feet for a 300-foot radius curve; and the minimum widening is 1 foot on a 1,000-foot radius curve. No extra width is added on curves having a radius greater than 1,000 feet.

The widening is accomplished by adding a strip on the inside of the normal width of pavement, this strip being maintained at its uniform (maximum) width from a point on the curve 25 feet from the P. C. to a point on the curve 25 feet from the P. T. as shown on the sketch. This strip is tapered off at the ends so that it runs out at points on the normal straight pavement beyond the P. C. or P. T., the distances varying with the sharpness of curvature. Co-ordinates are given in the table for locating a sufficient number of points on this easement curve which forms the inner edge.

Superelevation on Curves

The rate of bank varies from 0.070 of a foot per foot of width of pavement for curves of 300-foot radius to 0.021 of a foot per foot for curves of 1,600-foot radius, which is the flattest curve banked. This minimum rate of 0.021 is the same as that used for the crown on a normal (straight) section.

The banking is accomplished by keeping the grade of the inside edge of the pavement at the theoretical center line grade of the profile *minus* the normal crown. To this grade of the inner

edge the total bank is added to obtain the grade of the outer edge of the pavement.

Full bank is maintained over the same length of curve as the full widening (*i.e.*, from a point on the curve 25 feet from the P. C. to a point on the curve 25 feet from the P. T.). The transition from full bank to the normal crown section is obtained by means of a reversed vertical curve which furnishes the grade of the outer edge. This reversed curve extends from the point of full bank to a point on the straight road beyond the P. C. or P. T., the distance varying with the sharpness of curvature. Co-ordinates are shown in the table for locating a sufficient number of points on this reversed curve.

In construction a curved screed is used on the normal crown section and a straight screed on the banked section, and it is necessary to provide a means of transition between them. This may be accomplished by using the curved screed on the inside portion of the pavement up to the point where the banking of the outside edge is level with the center grade. Then it is necessary to provide a transition in a distance of 20 feet or so until the straight screed may be used. On the outer portion of the pavement a similar transition must be made from the end of the normal crown section to the point at which the outer edge is level with the center grade, beyond which the straight screed may be used.

Practical Field Procedure

Various methods may be used in the field to accomplish this transition. One method is to use the curved screed on the outer portion up to the point where the outer edge is level with the center grade. Then build a false side form about 16 feet long with the end nearer the tangent set about 4 inches higher than the original form, and the other end (toward the curve) set level with the

-PLAN-



**EXAMPLE OF EASEMENT OFFSETS AND BANKS
FOR RADII 500' TO 599'**

Tabulation for 20' Road

Widening=Offsets in feet from inside edge of unwidened curve

Bank = Superelevation in feet of outer edge, inner edge = 0.00

profile theoretical center grade minus normal crown

For the purpose of the present study, the following hypotheses were formulated:

Widening will remain the same as for

20' road Banking will vary in the proportion $\frac{19}{9} = \frac{9}{19}$

Note - Distance equals length from PC or PT to point of offset.

Full Bank and Widening 25' from PC or PT

FIG. 1.—WIDENING AND BANKING OF HIGHWAY CURVES

Standard adopted by the Massachusetts Department of Public Works

original form. If the straight screed is now used from the center line form to this false side form it accomplishes the transition on the outer portion satisfactorily.

On the inside the curved screed may be used and the transition accomplished by similar use of a false form and straight screed. On the inside the transition begins at the point it left off on the outside (*i.e.*, where the outer edge is level with the center grade).

The diagram shows a typical example of the use of this table for widening and for banking a curve when the radius is between 500 and 599 feet.

Curing Concrete in a Semi-Arid Climate

"Studies of Methods of Curing Concrete in a Semi-Arid Climate," by Harrison F. Gonnerman and C. L. McKesson has just been published as Bulletin 15 of the Structural Materials Research Laboratory, Lewis Institute, Chicago.

This investigation was conducted at Sacramento, Calif., as a co-operative research by the California Highway Commission and the Structural Materials Research Laboratory. The climatic conditions were quite unfavorable for the proper curing of unprotected concrete, but are typical of those encountered in semi-arid regions.

The experiments were carried out on 7" x 10" x 38" Portland cement concrete beams made out of doors and cured in the open. Curing methods included: (1) covering of wet earth, (2) covering of asphaltic paper, (3) surface application of calcium chloride, (4) surface application of sodium silicate, and (5) air exposure.

In comparing the relative efficiency of the different curing methods, the strength of the concrete cured with earth wet 7 and 14 days (which showed practically

identical results) was taken as the standard.

The principal conclusions from the tests are:

(1) A curing method is efficient which maintains the moisture content of the concrete during the early stages of hydration, about equal to the original mixing water. Wet-earth curing gave the best results; this method apparently supplied moisture in sufficient quantity to replace losses due to evaporation and to absorption by subgrade. Curing methods which permitted high evaporation losses gave concrete of low strength.

(2) The tests showed that concrete cured under earth wet for 7 or 14 days was only slightly stronger than when cured under earth wet for 3 days. In view of this and of the small rate of increase in strength after the 14th day it may be concluded that with temperature no lower than prevailed in these tests (70° F.) concrete pavements cured by covering with wet burlap for 16 to 24 hours and then with earth kept wet for 7 days, may safely be opened to traffic in 14 days.

(3) Curing with a surface application of flake calcium chloride, 2½ pounds per square yard, gave strength-ratios of from 88 per cent at 7 days to 83 per cent at 90 days; with less than this amount and with 3 and 5 pounds, there was a slight reduction in strength. When the calcium chloride was washed off after 3 hours, the strengths were reduced perceptibly; washing off calcium chloride after 1 day gave essentially the same strengths as when left on the surface.

Surface hardness for calcium chloride-cured beams was considerably less than for beams cured with wet earth or with asphaltic paper.

(4) For beams molded and cured in concrete forms using calcium chloride, 2½ pounds per square yard, the strength-ratios ranged from 100 per cent at 14 days to 89 per cent at 90 days. The

strengths in this case were about 12 per cent higher than for beams molded in wood forms and cured with a similar amount of calcium chloride.

(5) Asphaltic paper curing gave average strength-ratios ranging from 92 per cent at 7 days to 78 per cent at 90 days; surface hardness was almost as high as for wet-earth curing.

(6) Both air curing and sodium silicate curing showed low strength and surface hardness. The strength-ratios for these

methods of curing ranged from about 77 per cent at 7 days to 74 per cent at 90 days.

(7) Indentation loads used in measuring surface hardness averaged 21 times the modulus of rupture; the greatest surface hardness was found for concrete of highest flexural strength. This method of test showed that calcium chloride, sodium silicate and air-curing produced a more friable surface than wet-earth or paper curing.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

BOSTON SOCIETY OF CIVIL ENGINEERS

OCTOBER 21, 1925. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, and was called to order by the President, Richard K. Hale, at 7.15 P.M.: There were about 160 members and guests present.

The President stated that the minutes of the previous meeting (September 30, 1925) would appear in the October JOURNAL.

The Secretary reported for the Board of Government the names of those elected to membership:

Members: Henry J. Bateman, Hans M. Johnson, Hugh D. Chase,* Thomas P. Coogan,* Ralph R. Dresel,* Samuel T. Drew,* Henry F. Hill, Jr.,* Walter C. Richards.* *Juniors:* Howard J. Sprott, Zaven Malkasian.

The President reported that the Board of Government had voted to recommend to the Society that By-Law No. 1 be amended to read as follows:

"1. MEETINGS. — Regular meetings of the Society shall be held on the fourth Wednesday in January, and on the third Wednesday of the other months, excepting July and August, unless otherwise authorized by the Board of Government."

He stated that such a change in the By-Laws would allow greater flexibility in the arrangement of meetings and would enable the Society to co-operate to the fullest extent with The Affiliated Technical Societies of Boston in the arrangement of its program. It was voted unanimously that By-Law No. 1 be amended to read as follows:

"1. MEETINGS. — Regular meetings of the Society shall be held on the fourth Wednesday in January, and on the third Wednesday of the other months, excepting July and August, unless otherwise authorized by the Board of Government."

(An amendment to the By-Laws requires a two-thirds vote at two successive regular meetings. It will therefore be presented for final action at the November meeting.)

Acting upon the recommendation of the Board of Government, the Society voted: "That the Board of Government be authorized to use the income from the Permanent Fund for the current year to such an extent as they deemed necessary in payment of the current expenses of the Society."

(This matter requires a two-thirds vote at two successive regular meetings and will be presented for final action at the November meeting.)

* Transferred from grade of Junior.

The President then presented to John R. Freeman, an Honorary Member of the Society, engrossed copies of the resolutions adopted by the Board of Government and by the Society on March 25, 1925, in appreciation of his generous gift of \$25,000 for the establishment of the "FREEMAN FUND." Mr. Freeman responded briefly, telling of his great interest in the Society and of the inspiration and encouragement he had received through its activities in his early years. He said that this gift was in recognition of the debt of gratitude which he felt he owed the Society.

Mr. Freeman then spoke on the subject of a "National Hydraulic Laboratory," describing what had been done abroad and illustrating his talk with lantern slides and moving pictures.

Following these remarks, Mr. Freeman discussed the Report of the Engineering Board of Review of the Sanitary District of Chicago on the "Lake Lowering Controversy," confining his attention to the question of lake levels, navigation and water power. Mr. Harrison P. Eddy then discussed the Chicago problem, dealing particularly with sewage disposal and related matters. These talks were illustrated by lantern slides. Both Mr. Freeman and Mr. Eddy were members of the Engineering Board of Review, and the members of the Society were afforded an excellent opportunity of learning of the conditions surrounding the Chicago problem.

After a brief discussion, the meeting adjourned at 9.30 P.M.

J. B. BABCOCK, *Secretary*.

DESIGNERS SECTION

OCTOBER 14, 1925. — The regular October meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6.07 P.M. today in the Affiliation Rooms.

The minutes of the July meeting were read and approved.

The chairman introduced Mr. R. K. Hallock of the Aberthaw Company, Boston, who read a paper on "Theory Versus Practice in Concrete Construction." A general discussion followed the paper.

There were 50 members and visitors present.

The meeting adjourned at 7.30 P.M.

SCOTT KEITH, *Clerk*.

APPLICATIONS FOR MEMBERSHIP

[November 16, 1925.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

GILLESPIE, ROBERT, Watertown, Mass. (Age 51, b. Londonderry, Ireland.) From 1892-1902, business training, including office, foundry, machine shop, and as general manager for two years. From 1902-14 associated with firm in England manufacturing steam engines, boilers, etc.; experience in buying, selling and general management. Attended Nottingham University for three years, taking mechanical engineering; 1914-22, with firm manufacturing cranes and hoists; 1922-25, in business for self in Boston, manufacturing cranes, ash hoists, etc. Refers to F. A. McInnes.

KLEINERT, ALBERT E., Jr., Jamaica Plain, Mass. (Age 34, b. Brooklyn, N. Y.)

Graduate of Mass. Inst. Tech., in civil engineering, with degree B.S. With the New England Construction Co. for two and one-half years inspecting and detailing structural steel; two years with Holtzer-Cabot Electric Co., detailing and production; one year with F. O. Lewis, structural design; three and one-half years in Department of Public Works, Highway Division, where he is at present located. Refers to J. B. Babcock, G. E. Harkness, L. M. Hersum, Beardsley Lawrence, J. H. O'Connor.

MELLOR, FREDERICK, Boston, Mass. (Age 21, b. New Bedford, Mass.) Senior at Northeastern University. On the co-operative plan he has been employed by A. B. Drake. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

MINER, REGINALD BODLEY, Wellesley Hills, Mass. (Age 26, b. Melrose, Mass.) Graduate of Dartmouth College, 1921, with degree of B.S., also of Mass. Inst. Tech., 1924, with degree of S.B. in architectural engineering. Four months with Blackall, Clapp & Whittemore, architects, in 1922, as inspector on concrete work; from July to November, 1924, was employed as executive assistant with the National Fire Protection Association; since November, 1924, has held present position as structural designer, checker and inspector, for Monks & Johnson. Also is teaching structural design at Wentworth Institute, evening courses. Refers to J. J. Harty, H. W. Hayward, Granville Johnson, W. H. Lawrence, Eugene Mirabelli, Dean Peabody, Hale Sutherland.

SZLANDA, STANLEY, Fall River, Mass. (Age 20, b. Fall River, Mass.) Student at Northeastern University. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

TRAVERSE, IRVING, Boston, Mass. (Age 21, b. Boston, Mass.) Attended Northeastern University, 1922-24 with Baker Bros., also for legal collection agency; at present is rodman and engineering assistant in Division of Highways, State Department of Public Works. Refers to H. B. Frye, Anselmo Krigger, E. O. Stearns, Julius Waldman, Charles Weller.

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ZAVEN MALKASIAN, 249 Boylston Street, Watertown, Mass.

BOOK REVIEW

"Materials Testing," by Irving H. Cowdrey, Assistant Professor of Testing Materials, and Ralph G. Adams, Instructor in Mechanical Engineering, Massachusetts Institute of Technology. First edition, 1925. McGraw-Hill Book Company, Inc., New York. 129 pages.

This book should be of interest to every one connected with the testing of materials and the preparation of specifications.

The fundamental theory of testing materials is presented concisely, and terms, the interpretation of which often cause trouble, are defined in an authoritative manner.

The subject-matter deals with the use and calibration of the more common testing machines; a detailed discussion of tension, compression, transverse and torsion tests and the necessary apparatus required; the proper form, size and preparation of test specimens; methods of holding and loading test pieces; the examination of fractures and what may be learned from them; hardness testing and the comparison of various hardness scales; the testing of cement, sand, stone and concrete; the testing of timber and the preparation of graphs. A brief appendix presents condensed specifications and the physical properties of the more common materials.

Although this book was prepared primarily for students and to accompany a laboratory course, engineers and others should find it valuable as a reference.

BOSTON SOCIETY OF CIVIL ENGINEERS

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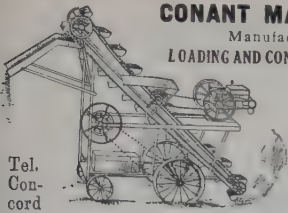
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